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Biofilm Simulation

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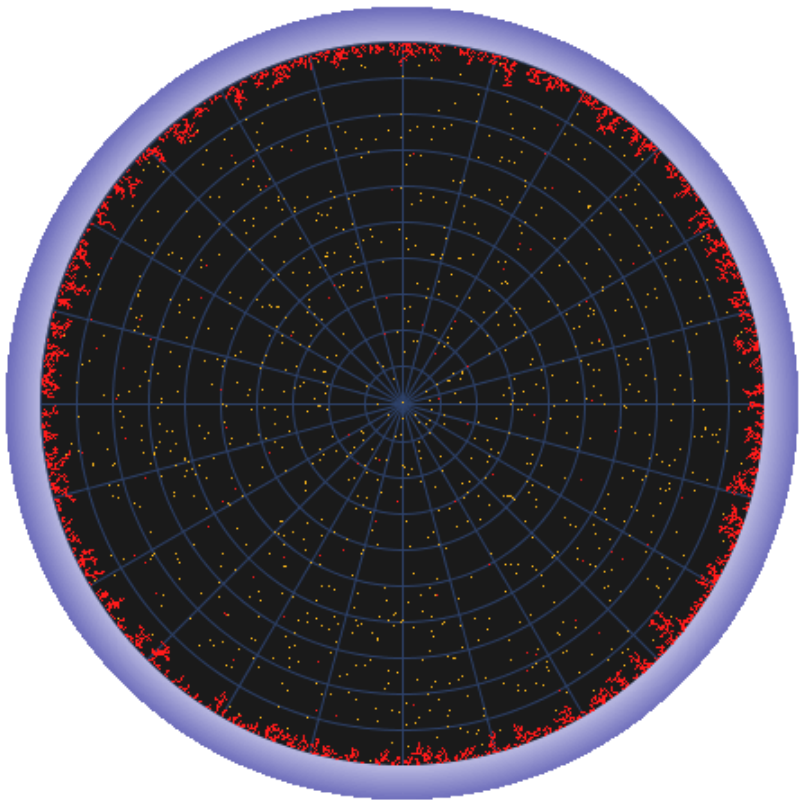
Aims of biofilm simulation



- Model the growth of bacteria and formation of biofilms under static or flowing conditions (i.e. in pipes)
- Model effects of biocide on biofilms, particularly then extension in contact time required to achieve growth control
- Application in the area of manufacturing plant hygiene.

Rules of simulation (1)

- Random walk particles of bacteria, food and biocide inside a pipe
  - 'Food' represents a generic metabolite rather than having several different classes (e.g. carbon source, minerals, oxygen)
  - Likewise 'Biocide' represents all antibacterial agents
  - Model could be extended to include different classes of biocide and/or food as required
- Particles rebound off (or stick to) pipe walls and fixed bacteria
- Food and biocide particles are absorbed by bacteria
  - Well fed bacteria can divide
  - Poisoned bacteria die
- Defined initial concentrations of the different particle types
- Flow (perpendicular to cross-section) displaces random particles with new particles according to inflowing concentrations

Rules of simulation (2)

- Particles position and speed are calculated as floating point values
- Particles are aliased to integer screen coordinates in order to carry out collision detection (same coordinates can be used for drawing)
- When fixed bacteria divide they move into empty space (jittered in screen coordinates)
- Event probabilities
  - Absorption of food or biocide (=1, activities control effectiveness)
  - Adsorption onto pipe surface and fixed bacteria
  - Breeding once sufficient food has been absorbed
- Activities
  - Food, controls amount of food required before bacteria can multiply
  - Biocide number of particles required to kill a bacterium
- Dead bacteria can be replaced by inflowing fluid but do not detach if they are fixed to the pipe wall
- If a fixed cell is isolated on all 8 sides then it detaches and becomes mobile again